NEW OR LITTLE KNOWN PERMIAN VERTEBRATES. PARIOTICHUS.[1]

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The University of Chicago Expedition to the Permian of Texas during the autumn of 1908 was very fortunate in finding a skeleton of a small reptile enclosed in a nodular matrix, probably the most complete of any specimen hitherto obtained from that formation. It is of especial interest since it gives, for the first time, a natural skeleton of a cotylosaur with all its bones in anatomical relations, scarcely a single one disturbed by extraneous force in fossilization. The original nodule measured about six inches in its greater, by five in its lesser diameter, and about two inches in thickness. The nodule, as discovered, was split horizontally, the thicker portion enclosing most of the skeleton lying upon its back; the thinner with portions of the bones partly enclosed in it, and with the right front leg almost wholly so. One small piece of the thicker side, and a yet smaller fragment of the thinner were not recovered. The missing portions, however, are of minor importance, and are in part supplemented by the two blocks. The specimen was discovered on a gently sloping surface near the Wichita River, north of Mabelle, by Mr. Paul Miller.

The material of which the nodule is composed is a rather hard argillaceous limestone, and has necessitated very patient labor on the part of Mr. Miller, with awl and needle, in its preparation, many of the bones being so small as to require the use of a magnifying glass. The skeleton, which measures nearly fifteen inches in length, is closely coiled, the tip of the tail lying under the front extremity of the skull. As exposed on the two blocks, the hyoid bones are in place; the pectoral girdle is very slightly displaced, with both arms articulated; the right arm is strongly flexed at the elbow, with its outspread hand underlying the pos-

[1] "Cotylosauria," *Journal of Geology*, XVI., p. 139; *Lysorophus*, this journal, XV., p. 229; *Diplocaulus*, *Trans. Kansas Acad. Science* (in press); *Trematops*, *Journal of Geology*, XVII. (in press).

terior part of the right mandible; the left arm is extended backward close to the vertebral column, its fingers protruding from the edge of the block and for the most part lost; both hind legs

FIG. 1. *Pariotichus laticeps* Williston. Photograph of specimen, from the thicker half of nodule; natural size.

are articulated throughout, turned backward by the side of the tail, and not a single bone seems to have been lost or disarticu-

lated ; both the feet, unfortunately, are lying in part upon their fibular side, concealing some of the bones ; the tenth to the thirteenth caudal vertebræ are disarranged and partly missing, probably due to the fact that they lie partly over the right foot ; the small terminal vertebræ of the tail are also missing, where

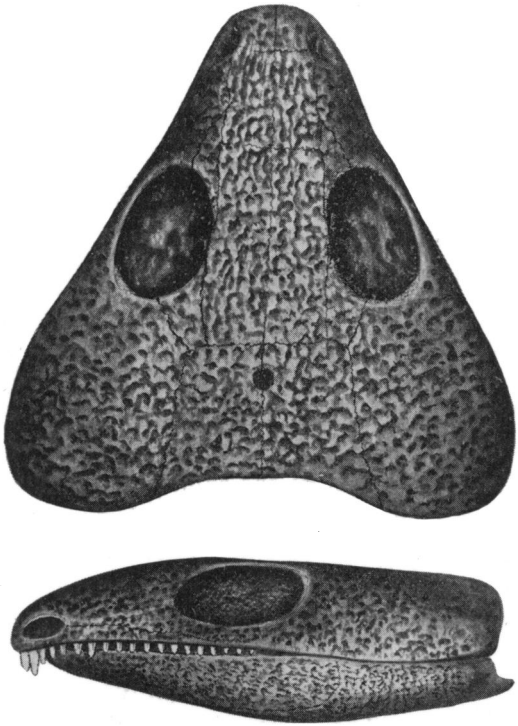

FIG. 2. *Pariotichus laticeps*, skull from above and from the side ; natural size.

they protruded from the margin of the slightly eroded nodule. On the whole, the only doubtful details of the skeleton are the number and arrangement of the tarsal bones, and the extreme tip of the tail. The extreme terminal phalanges of the first three fingers, because of their minute size, may have been destroyed in the preparation of the block, or slightly dislodged.

Skull (Figs. 1, 2). — The skull is in a marvellously perfect condition, the only injury it has suffered being a very slight erosion of the extreme tip of the muzzle where it protruded from the edge of the nodule. It is remarkable among reptiles for its

great width and depression, its width posteriorly being fully equal to its length. The pitting of the upper surface is small and reticulate, with a slight, though distinct, indication of longitudinal ridges. The parietal and frontal bones posteriorly are slightly concave in the middle. The nares are small, situated nearly at the extremity of the muzzle, oval in shape and directed more outward. In front of the orbits the face is a little constricted, with the sides more strongly convex. From the front of the orbits the lateral lobe of the cranium is convex outward to about midway between the orbit and the hind border, where the curve is slightly inward. There is a rather strong emargination of the hinder border of the cranium in the middle, with the outer third on each side gently convex or nearly straight. The large orbits are located a trifle in front of the middle of the skull. They are oval in outline, with the long diameter antero-posterior, measuring eighteen millimeters in length by fifteen in breadth. The plane of their margins is directed a little forward and upward at an angle of about 45°. The large pineal foramen is nearly midway between a line drawn through the posterior margin of the orbits and the hind border of the skull in the middle line. The sutures of the skull are, for the most part, indicated by very delicate lines, requiring a hand lens to follow. I have given such as I feel sure of. The plane of the upper surface of the skull is nearly horizontal as far forward as the front end of the orbits, whence it slopes gently to the front extremity, with a slight convexity. The mandibles are in position on the under side, slightly pushed to the left. The symphysis is short, the rami rather narrow in front, their outlines very much like those of the side of the cranium, curving inward posteriorly. They are broadest and deepest a little back of their middle, or opposite the transverse bones, which abut against them. Distinct sutures for the splenial, dentary and angular are seen anteriorly on the outer side. The dentary ends by a broad curve upward, with the slender prolongation of the angular enclosed between it and the margin of the splenial below. At the hind extremity the small, inwardly curved angular process is visible. The slight lateral pressure upon the mandibles has left exposed the insertion of the maxillary teeth of the right side, but the very delicate teeth them-

selves have suffered in the preparation, though their roots are clearly to be seen. On the premaxillary there are three stout teeth, the largest of the series of either jaw. Of these the third is the smallest, the first and second of nearly equal size, judging from their roots. Back of the premaxillary teeth, in addition to the roots seen on the right side, the teeth themselves are preserved on the left side, crowded rather closely upon the mandible. They are all rather small, the fifth or sixth of the series, counting the premaxillary teeth, about a third of the distance to the orbit back of the narial opening, is the largest. They are all rather obtusely pointed, and are separated by spaces about equal to or somewhat less than the width of the teeth themselves. In a space of ten millimeters back of the largest maxillary tooth there are five teeth. The mandibular teeth cannot be made out. It is altogether probable that there are additional teeth in secondary rows upon the maxilla and dentary, but the close union of the mandibles with the cranium prevents their detection.

The palate is very fully exposed and is undistorted. The internal nares, placed far forward, are above the mandibles and yet concealed by the matrix. The broad, flat palatines and vomers — for sutures are nowhere determinable — diverge very gradually to about midway between the mandibular symphysis and the basisphenoid, where they separate more widely, leaving a rather large ovate space, yet filled in with matrix. I can distinguish no presphenoid in this ovate space, but it is possible one exists directed obliquely toward the roof of the skull. Along the margin of these bones by the side of the ovate opening and anteriorly are one or two rows of minute tubercular teeth, and, just in front of the descending convexity of the transverse, there is an oblique row of six or seven palatine teeth on each side. The lateral palatal plates descend posteriorly in a convex surface, to nearly the lower margin of the mandibles, with a thinned, convex posterior margin. The lower convexity of these transverse bones (for they are doubtless separate elements, though they have never been suturally distinguished) is covered with a patch of tubercular teeth. The union of the pterygoids with the basisphenoid is very evident in the constriction at either side of the front of the basisphenoid, but the suture is not determinable. From this con-

striction and union with the short basipterygoid processes of the basisphenoid, the posterior plates of the pterygoids diverge to the inner side of the quadrates, opposite the inner angle of the articular bone of the mandible. These plates have a thin, straight, horizontal lower margin, whence they slope inwardly and upwardly into a somewhat concave surface, narrow and nearly vertical in front, widened behind, leaving a small oval space anteriorly between them and the basisphenoid. The basisphenoid is narrow in front, gently widened behind, shallowly concave in the middle and limited on either side by a rather rugose ridge. From near the posterior, somewhat divergent, ends of these ridges, a slender bone runs outward and backward by the side of the inner margin of the pterygoid plate. It is in all probability the stapes. Upon the whole, the structure of the palate and occipital region is quite like that of *L. hamatus*, which will be fully described and illustrated in a future paper from a remarkably perfect specimen in the University collections. Lying under the palate were two slender rods. One of these has been necessarily destroyed in getting to the palatal surface; the other still remains in the matrix. They nearly meet in the middle anteriorly, just back of the interpterygoid vacuity, diverging posteriorly nearly parallel with the margins of the pterygoid plates to near the quadrate. Back of these and articulated with them are a pair of more slender bones bent inwardly near their middle, and terminating acutely behind, nearly parallel with the front margins of the clavicles.

Vertebræ. — The vertebræ are united in a continuous series from the skull to near the tip of the tail, forming a U-shaped curve. The pectoral girdle still conceals the anterior five or six of these and the posterior seven of the presacral series were lost in the missing fragment of the nodule. However, the top of the nodule over these missing seven vertebræ has preserved in part impressions of them, and, inasmuch as the vertebræ themselves, where exposed, are all of precisely the same length, seven and a half or eight millimeters, the number of presacral vertebræ in the entire series is determinable with but slight chance of error. This number was either twenty-three or twenty-four. Broili has determined the number of presacral vertebræ in *Labidosaurus hamatus* as either twenty-four or twenty-five; twenty-three or possibly

twenty-four is the number of presacral vertebræ in the rhachitomous *Trematops* as determined by me; twenty-three or twenty-four was the number ascertained by Thevenin in *Sauravus costei*, a probable reptile from the Upper Carboniferous of France; and I believe that *Isodectes Copei*, from the Lower or Middle Mississippian of Linton, Ohio, had the same number. This uniformity seems to be more than a coincidence. Of this number the atlas alone can be called, as in the amphibians, a true cervical. All the vetebræ bore ribs, and, inasmuch as there was no sternum in these early forms, a distinction into neck and trunk is impossible. The centra of our specimen are rather slender — more so than in *Labidosaurus* — each with a marked constriction in the middle. Some of the posterior vertebræ lie partly upon their sides, disclosing the attachment of the ribs. No distinct process is seen on the centrum for them, differing in this respect from *Labidosaurus*, though doubtless the lower part of the proximal extremity of the ribs did articulate with the centrum. A small intercentrum is present in one or two of the anterior vertebræ, and a small space is seen between the lower edges of the centra of all. The sacral vertebræ are of course not visible in the pelvis. There were, in all probability, but two sacral vertebræ, though this is not certain since another form of Permian reptile, which will be illustrated and described later, has three, while *Labidosaurus* has but two. If the vertebræ above the pubes and ischia are of the same length as those immediately following or preceding, there are six concealed from view, one of which is the first presacral, and three the basal caudals. Behind the pelvis eight caudal vertebræ in a connected, gently curved series are visible. They are somewhat shorter and more slender than the presacral vertebræ, the entire series measuring about forty-six millimeters. Beginning with the second of these there are long, slender chevrons, each reaching to beyond the end of the next succeeding centrum, that is, about fourteen millimeters in length. Just how far back these chevrons continue is not certain, but at least eight centra bore them. The first entire vertebra back of the pelvis bears a long, curved rib on each side, springing from the anterior end of the centrum. The next two vertebræ doubtless have similar, but short ribs, though only the

proximal ends of them are seen. I do not think that the following vertebræ bore ribs, or, if so, they were much shorter. I can find no indications of such. In the restoration, these caudal ribs are shown directed backward, as in the matrix. Doubtless in life they were directed more downward, indicating a thick basal portion of the tail, probably compressed from side to side. Beyond the eighth visible caudal there is a break in the series, the only indication of contemporary extraneous force shown in the entire skeleton; and this may have been due to the fact that this part lies somewhat under the right hind leg in the nodule — that is, if the skeleton was originally fossilized in a prone and not supine condition. Following this gap there are three articulated vertebræ in line with the curvature of the basal portion of the tail. They are more slender than the preceding ones and clearly lie in their original position, the intervening five vertebræ having been dislodged, fragments of which are still preserved near the break. The extreme tip of the tail came near the margin of the nodule, at or below the tip of the muzzle, and has been destroyed by the erosion of the nodule. Perhaps a half dozen very small vertebræ are missing here, making altogether about twenty-five vertebræ for the number in the tail, or for the entire column about fifty, with a possible error of three or four more.

The dorsal ribs have an expanded proximal end, but without distinct differentiation into head and tubercle. The first one visible is attached to the vertebra concealed in part by the caudal end of the interclavicle, that is, the seventh or eighth of the series. It is altogether probable that the first four or five ribs were shorter, with expanded distal ends, as in *Labidosaurus*. From the eighth to the seventeenth the ribs lie nearly parallel on the right side, on the left being crowded more together at their ends. The longest of them measure forty-six millimeters along their considerable curvature. They are slender throughout. The broken ends of the eighteenth and nineteenth are visible in the matrix, but little if any shorter than the preceding ones. A fragment of what should be the twenty-first or twenty-second is also visible on the right side, but its length is not determinable. I have, therefore, shaded the last four ribs in the restoration, and it is possible these vertebræ were entirely ribless, as I have decided they were in *Labidosaurus*.

Pectoral Girdle. — The pectoral girdle lies almost perfectly in position, the hind end of the interclavicle only, turned slightly to the right, and the right coraco-scapula pushed slightly forward, or the left one backward. It is very certain that the girdle was attached immediately back of the skull, the front part underlying the occipital condyle even. In structure it is almost identical with that of *Labidosaurus*, as figured by me. The position in which they lie has slightly separated the clavicles at their scapula, attachment. I find no indications of a cleithrum. It is very evident that the coracoids in life were in immediate contact along the median line, covered over by the prolongation of the interclavicle. The scapulæ curve upward at an angle of about forty-five degrees from the plane of the coracoids. Possibly this angle has been reduced slightly by pressure, but I think not. The scapulæ are directed, not backward, as has been supposed, but obliquely upward.

Front Legs. — The humerus is of the usual shape, expanded proximally and distally in planes meeting each other at an angle of sixty or seventy degrees. The bone, like all other parts of the appendicular skeleton, is distinctly more slender than in *Labidosaurus*. The radius is a rather slender bone, cylindrical at its proximal, flattened and expanded at its distal extremity. The ulna, much broader and thicker at its proximal end, has a distinctly produced olecranon, and the curvature of the rather slender shaft in the middle is distinctly away from the radius. The most of the forearm and foot of the right extremity are preserved in the thinner block, the proximal ends of the radius and ulna in the thicker close by the right pubis. The hand, as thrust forward below the right mandible, is outspread and fully articulated, the middle of the wrist somewhat depressed by the angle of the mandible in the mud, slightly turning the distal end of the ulna. The terminal phalanges were probably present or but slightly dislodged, but their minute size has made it almost impossible to detect and work them out from the hard matrix. The carpus clearly agrees in its chief features with the carpus of *Labidosaurus "incisivus,"* as figured by Case and myself, save that the parts were reversed in the figures. I give herewith a better figure of the labidosaur carpus, which has been more completely removed from

its matrix (Fig. 4). Because of the compression of the middle part of the carpus in our specimen, it is impossible to be quite sure of the presence of both centralia. The radiale is much broader than long, articulating with the radius, the distalia of the second and third digits, and with one or possibly two centralia. The ulnare is a much larger bone, articulating proximally with the ulna, distally with the two inner distalia, and on the outer side with the

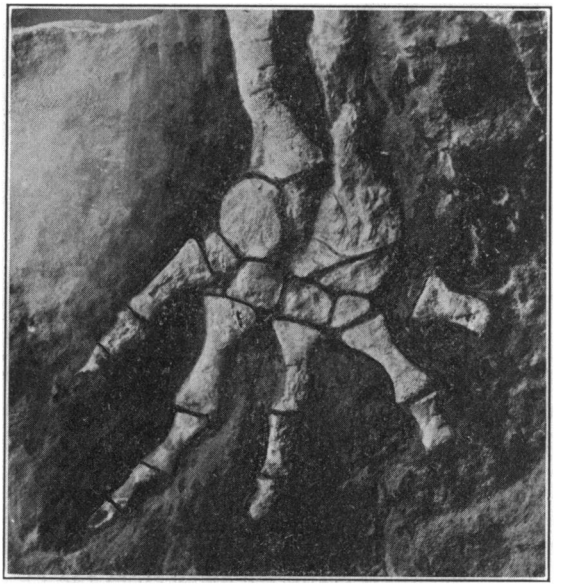

FIG. 3. *Pariotichus laticeps*. Photograph of right front foot, from thinner half of nodule; natural size.

intermedium. That there is a free intermedium here as in *Labidosaurus* is certain, but I cannot be quite sure of its extent, a part of it being apparently covered over by the radius. It articulates, as in *Labidosaurus*, proximally with the ulna and distally with a centrale. Five digits are present, as was to be expected. The first is represented by its metacarpal only, either slightly removed from its articulation with the radiale, or, what is more probable, with its distale lost, or cartilaginous. In the restoration it is shown removed from the carpal bones as in the photograph of the hand also given herewith (Fig. 3). The first metacarpal is the shortest of the five, and is only moderately ex-

panded distally. No phalanges are preserved. The second metacarpal is much longer than the first, and is much constricted in its middle. It has one short phalanx articulated with it, but little more than half the length of the metacarpal. Additional phalanges are not preserved, but, from its size, it seems very probable that two more, and not more than two, were originally present. The third metacarpal is much like the second, but is a little longer. Two phalanges are present, the first about two thirds the length of the metacarpal; the second fragmentary. There may have been a third, ungual phalanx present. The fourth metacarpal is the longest and stoutest of all, its proximal articulation more oblique than is the case with the preceding one. The first phalanx is about three fifths the length of the metacarpal. The second phalanx, much shorter and smaller, has at its tip a small fragment. There may have been a fourth phalanx, though there is not much probability of it. The fifth metacarpal is a little shorter than the fourth, somewhat curved and more slender. It has a small and short proximal phalanx and a fragment of a distal one at its tip. In all probability there were no more. It is, it is seen, impossible to say with certainty what the phalangeal formula of *Pariotichus* was, save that quite surely it was not that of the modern lizards and *Sphenodon*, 2, 3, 4, 5, 3. In much probability it was 2, 3, 3, 4(3), 2.

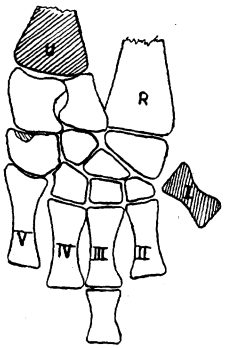

FIG. 4. *Labidosaurus*. Carpus; one half natural size.

Pelvis. — The under side of the pelvis lies in perfect preservation and position. It is, like the pectoral girdle, of the "old fashioned" type, elongate and plate-like, without thyroid foramen. The two sides meet in a long median symphysis, closely applied, but not sutural. The pubes, broadest in front, have a slight emargination in the middle in front. The small pubic foramen lies near the acetabulum, at the junction of the first and second thirds of the combined bone. Just inside this foramen, and a little to the outer side of the middle of each pubis, a pronounced thickening or ridge runs forward to the anterior margin, forming a

shallow fossa on each side of it. The pubo-ischial suture is, apparently, a little back of the pubic foramen, running transversely across. It is not at all distinct, and I am not sure of it. Lying in the median emargination of the pubes there are three or four very slender ventral ribs, and by their side, a fragment of what appears to be a thin plate, which may have articulated with the thickening of the front margin before mentioned, a thickening characteristic of all the smaller cotylosaurs, apparently. The pelvis, so far as it can be seen, is almost identical with that of *Labidosaurus*, and other Permian cotylosaurs, forms of which will be figured later.

Legs. — As stated, the hind legs are both preserved, trailing backward from the acetabulum, both of them somewhat bent at the knee. The femur of the right side suffered somewhat in the fracture of the nodule, and is only partly preserved. That of the left side, so far as it can be seen partly embedded in the matrix, agrees quite with that of *Labidosaurus*, though more slender. The tibia, also shown best on the left side, offers nothing unusual. The fibula, hitherto unknown in the cotylosaurs, is strongly curved, with a considerable expansion at its lower extremity, and with a small, rounded upper end. The feet, unfortunately, have both been preserved lying more or less on their fibular side, and in consequence with the toe bones more or less concealed. However, it is quite certain that no force was brought to bear upon them to displace them, save that of their own weight. The lower leg of the right side and the tarsus are spread out flatly, but with the digits piled upon each other. A large, flat fibulare articulates with the fibula of the right side in position, closely articulating on the inner side with another large bone, evidently the united tibiale and intermedium. Four tarsal distalia are visible. The shapes of the bones distinguished agree in general so well with those of *Labidosaurus* as figured by me, that I have no hesitation in giving the others from the same genus, shaded in the figure. The tibiale, however, must have been shorter than in *Labidosaurus*. As regards the toes, all five metatarsals are visible on one or the other side, and many of the phalanges, save those of the fifth toe. In the figure given in the restoration, the unshaded phalanges of the other toes are given precisely in the

positions they occupy with regard to the tarsus, so that the length of the toes is quite certain. Those phalanges which cannot be extricated from the matrix are shaded. In all probability the phalangeal formula is like that of the front feet; certainly there cannot be a greater number.

Six genera of Permian reptiles, all from Texas, are referred by Cope to the family Pariotichidæ; and, notwithstanding the difference in the teeth, I am disposed to add the seventh genus, *Labidosaurus*, to the same family. They are defined by Cope as follows:[1]

1. Teeth on the maxillæ and mandibles in a single series.....*Labidosaurus* Cope.
   Teeth in more than a single series.....2.
2. External nostrils inferior; mouth posterior in position; mandible short and with a few acute teeth.....*Hypnopous* Cope.
   External nostrils lateral.....3.
3. Palatal and splenial teeth with compressed crowns.....4.
   Palatal and splenial teeth obtuse, forming a grinding pavement; median maxillary and anterior incisor teeth enlarged.....*Pantylus* Cope.
4. Teeth equal, acute.....*Isodectes* Cope.
   Teeth increasing gradually in length anteriorly.....*Captorhinus* Cope.
   Teeth enlarged in the middle of the maxillary and anterior part of the incisor series.....*Pariotichus* Cope.

The genus *Helodectes*, provisionally placed in the Pariotichidæ, is distinguishable by the two rows of teeth on the jaws, the "bases of which are wide ovals, transversely placed."

Isodectes is figured by Cope as having the prefrontals and postfrontals meeting broadly over the orbits, widely excluding the frontals from the orbit. The skull, moreover, is much longer than broad in the type species, *I. megalops*. *Pantylus* also has the prefrontals and postfrontals meeting broadly as in *Isodectes* in the type species, *P. cordatus*, which, moreover, has a rounded muzzle, and is widely expanded posteriorly. *Captorhinus* has an elongate, pointed skull, with the orbits twice the diameter of the interorbital space. *Hypnopous* is wholly out of consideration because of the remarkable position of the nares. Assuming that our species has more than one row of teeth on maxillæ and mandibles, its exclusion from the labidosaurs is of course evident. As that character cannot be determined save by the mutilation of the otherwise perfect skull, the doubt must be left. By ex-

[1] *Proc. Amer. Phil. Soc.*, XXXIV., 1895, p. 445.

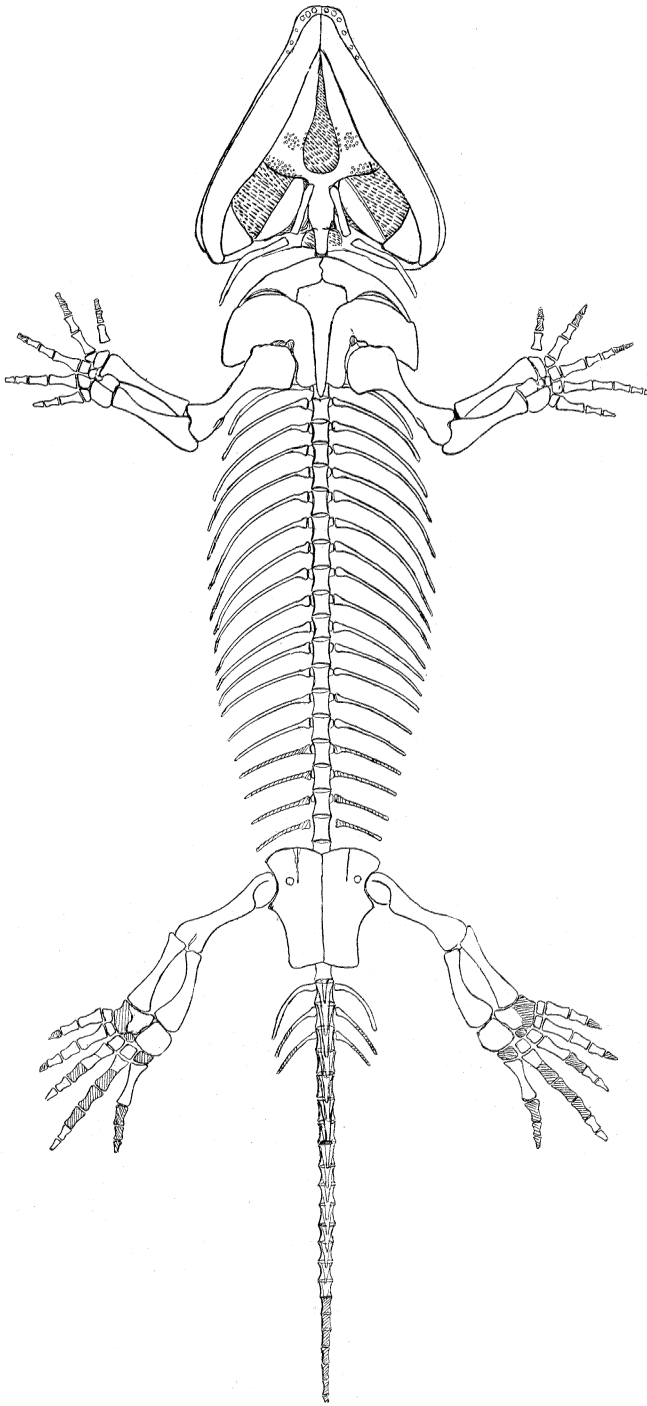

FIG. 5. *Pariotichus laticeps.* Restoration of skeleton ; one half natural size.

clusion, we have only the genus *Pariotichus* left, and in all its characters, so far as they have been developed in the known species of the genus, the agreement seems sufficiently certain. Six species of *Pariotichus* have been described. Of these, *P. brachyops* is excluded by the large maxillary tooth not being below the anterior border of the orbits, but much further forward, by the relative size of the orbits, etc. *P. aguti* is easily distinguished by the elongate shape of the head, its less depressed form, etc. *P. isolomus* differs distinctly in its less expansion posteriorly, its length being distinctly greater than its width, and the absence of a posterior emargination of the cranial border. *P. incisivus* has been wrongly identified as having a single row of teeth on mandibles and maxillæ by both Case and myself, whereas Cope distinctly figures it (*Trans. Amer. Phil. Soc.*, 1886, p. 290,

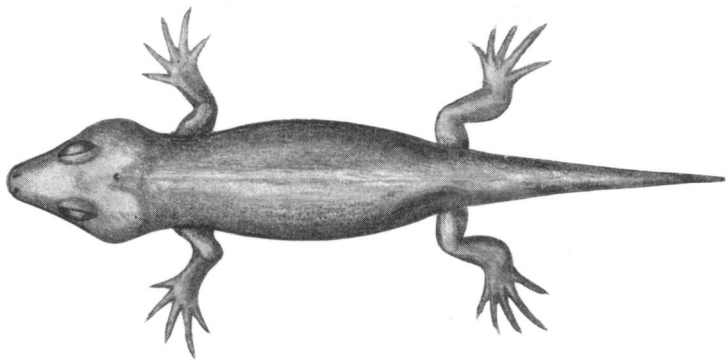

FIG. 6. Life restoration of *Pariotichus laticeps*; one fourth natural size.

Pl. II., Figs. 4 and 5) as having additional teeth. The form described by me as *Labidosaurus incisivus* is therefore something else. *P. incisivus* is described and figured by Cope as having a purely reticulated sculpture of the skull, which he accepts as of specific value. Our species has the sculpture, distinctly longitudinal, on the upper side of the skull anteriorly at least. *P. aduncus* is distinguished by the size of the orbits, etc. We have, then, but a single species left, *P. ordinatus* Cope, described from such scanty material that it is doubtful if an actual comparison of the type specimen would resolve doubt as to its identity with the species herein described. Our species may, therefore, be provisionally given the name of *P. laticeps*.